CLAIMS

What is claimed is:

1. A MEMS package, comprising:

a substrate with a MEMS structure fabricated on a surface of the substrate;

a cover plate bonded to the surface of the substrate by a bond ring;

an inner cavity defined by the substrate, the cover plate and the bond ring; and

a fill port defined by the substrate, the cover plate and a breach in the bond ring.

2. The MEMS package of Claim 1, further comprising:

fluid sealed within the inner cavity.

3. The MEMS package of Claim 2, further comprising:

a seal disposed in the fill port.

4. The MEMS package of Claim 1, wherein the bond ring comprises at least one of a glass frit, adhesive, eutectic solder, solder mask material, anodic bond, covalent bond, laser weld or Sol-gel material.

5. The MEMS package of Claim 3, wherein the seal comprises at least one of an adhesive, organic adhesive, epoxy, solder or glass-based sealant.

6. The MEMS package of Claim 3, wherein the seal comprises a curable adhesive.

7. The MEMS package of Claim 1, further comprising:

bond pads for making electrical connections to the MEMS package arranged in an exposed portion of the substrate.

8. A MEMS package adapted for use in a range of operating temperatures comprising:

a substrate with MEMS circuitry fabricated on a surface of the substrate;

a cover plate bonded to the surface of the substrate by a bond ring;

a fill port defined by the substrate, the cover plate and a breach in the bond ring;

an inner cavity defined by the substrate, the cover plate and the bond ring; and

fluid sealed within the inner cavity, the fluid having a coefficient of thermal expansion, wherein the inner cavity has a volume which is small enough so that expansion of the fluid throughout the range of operating temperatures is accommodated by deflections of at least the cover plate, substrate and bond ring.

9. The MEMS package of Claim 8, further comprising:

a seal disposed in the fill port.

10. The MEMS package of Claim 8, wherein the bond ring comprises one of a glass frit, adhesive, eutectic solder, solder mask material, anodic bond, covalent bond, laser weld or Sol-gel material.

11. The MEMS package of Claim 9, wherein the seal comprises at least one of an adhesive, organic adhesive, epoxy, solder or glass-based sealant.

12. The MEMS package of Claim 9, wherein the seal comprises a curable adhesive.

13. The MEMS package of Claim 8, further comprising:

bond pads arranged in an exposed portion of the surface of the substrate.

14. A MEMS assembly comprising:

a substrate with a plurality of MEMS structures fabricated at a plurality of respective die locations on a surface of the substrate;

a cover plate bonded to the surface of the substrate by a plurality of bond rings;

a plurality of inner cavities associated with respective die locations, each being defined by the substrate, the cover plate and one of the plurality of bond rings; and

a plurality of fill ports, each being defined by the substrate, the cover plate and a breach in the one of the plurality of bond rings.

15. The MEMS assembly of Claim 14, wherein the cover plate comprises a plurality of openings defining a plurality of exposed portions on the substrate.

16. The MEMS assembly of Claim 15, wherein:

a first group of openings define a first group of exposed portions, each of the first group of exposed portions being adjacent a fill port; and

a second group of openings define a second group of exposed portions on the substrate.

17. The MEMS assembly of Claim 16, wherein the second group of openings comprise slots.

18. The MEMS assembly of Claim 16, further comprising:

a plurality of bond pads on the surface of the substrate arranged in the second group of exposed portions.

19. The MEMS assembly of Claim 14, wherein the bond ring comprises one of a glass frit, adhesive, eutectic solder, solder mask material, anodic bond, covalent bond, laser weld or Sol-gel material.

20. A MEMS assembly comprising:

a substrate with a plurality of MEMS structures fabricated at a plurality of respective die locations on a surface of the substrate;

a plurality of cover plates and a plurality of bond rings, each plate being bonded to the substrate by at least one of the bond rings;

a plurality of inner cavities associated with respective die locations, each being defined by the substrate, a respective cover plate and a respective bond ring; and

a plurality of fill ports, each being defined by the substrate, the respective cover plate and a breach in the respective bond ring.

21. The MEMS assembly of Claim 20 further comprising:

bond pads arranged in exposed portions on the substrate.

22. The MEMS assembly of Claim 14, wherein the bond rings comprise one of a glass frit, adhesive, eutectic solder, solder mask material, anodic bond, covalent bond, laser weld or Sol-gel material.

23. A MEMS package comprising:

a substrate with a MEMS structure fabricated on a surface of the substrate;

a cover plate bonded to the surface of the substrate by a bond ring;

an inner cavity defined by the substrate, the cover plate and the bond ring; and

a fill port defined by the substrate, the cover plate and a breach in the bond ring, wherein the MEMS assembly was singulated from an assembly comprising a plurality of inner cavities.

24. The MEMS package of Claim 23, further comprising:
fluid sealed within the inner cavity.

25. The MEMS package of Claim 24, wherein the inner cavity was filled with the fluid prior to singulating the MEMS assembly from the assembly comprising a plurality of inner cavities.

26. A method of manufacturing a fluidic MEMS package comprising:
providing a MEMS assembly with a plurality of inner cavities at a plurality of respective die locations on a substrate, each inner cavity being defined by a cover plate, the substrate and a bond ring and being associated with a fill port defined by the cover plate, the substrate and a breach in the bond ring;
filling the inner cavities with fluid;
sealing the fluid in the inner cavities;
singulating a plurality of MEMS packages from the substrate.

27. The method of Claim 26, wherein:
filling the inner cavities with fluid comprises providing a vacuum in the inner cavity, providing an amount of fluid sufficient to fill the inner cavity at the fill port and providing pressure on the fluid to cause the fluid to fill the cavity.

28. The method of Claim 26, wherein filling the inner cavities with fluid is performed prior to singulating a plurality of MEMS packages from the substrate.

29. The method of Claim 26, wherein the bond ring comprises one of a glass frit, adhesive, eutectic solder, solder mask material, anodic bond, covalent bond, laser weld or Sol-gel material.

30. A method of manufacturing a fluidic MEMS package comprising:

attaching a cover plate with a plurality of openings to a substrate with a plurality of bond rings with breaches such that the cover plate, the substrate and the bond rings define a plurality of respective inner cavities and the cover plate, the substrate and the breaches define a plurality of respective fill ports;

filling the inner cavities with fluid;

sealing the fluid in the inner cavities;

singulating a plurality of MEMS packages from the substrate.

31. The method of Claim 30, wherein:

filling the inner cavities with fluid comprises providing a vacuum in the inner cavity, providing an amount of fluid sufficient to fill the inner cavity at the fill port and providing pressure on the fluid to cause the fluid to fill the cavity.

32. The method of Claim 30, wherein filling the inner cavities with fluid is performed prior to singulating a plurality of MEMS packages from the substrate.

33. The method of Claim 30, wherein the bond ring comprises one of a glass frit, adhesive, eutectic solder, solder mask material, anodic bond, covalent bond, laser weld or Sol-gel material.

34. A method of manufacturing a fluidic MEMS package comprising:

attaching a plurality of cover plates to a plurality of die locations on a surface of a substrate, the attaching being done with a plurality of respective bond rings, the bond rings having breaches, the respective cover plates, bond rings and the substrate defining a plurality of respective inner cavities and the

respective cover plates, breaches and the substrate defining a plurality of respective fill ports;

filling the inner cavities with fluid;

sealing the fluid in the inner cavities;

singulating a plurality of MEMS packages from the substrate.

35. The method of Claim 34, wherein:

filling the inner cavities with fluid comprises providing a vacuum in the inner cavity, providing an amount of fluid sufficient to fill the inner cavity at the fill port and providing pressure on the fluid to cause the fluid to fill the cavity.

36. The method of Claim 34, wherein filling the inner cavities with fluid is performed prior to singulating a plurality of MEMS packages from the substrate.

37. The method of Claim 34, wherein the bond ring comprises one of a glass frit, adhesive, eutectic solder, solder mask material, anodic bond, covalent bond, laser weld or Sol-gel material.

38. A method of filling a fluidic MEMS package comprising:

providing the MEMS package with an inner cavity and a fill port;

providing a vacuum in the inner cavity;

at an entrance to the fill port, providing an amount of fluid at least sufficient to fill the inner cavity; and

providing pressure on the fluid causing the fluid to fill the inner cavity.

39. The method of Claim 38, further comprising:

purging air from the inner cavity using a purge gas.

40. The method of Claim 39, wherein the purge gas has high solubility.

41. The method of Claim 39, wherein the purge gas is one of carbon dioxide or helium.

42. The method of Claim 38, further comprising:
providing a vacuum environment around the MEMS package.

43. The method of Claim 42, wherein providing a vacuum environment comprises placing the MEMS package in a chamber and evacuating air from the chamber.

44. The method of Claim 42, wherein providing a vacuum environment comprises assembling the MEMS package in a vacuum environment.

45. The method of Claim 38, wherein providing an amount of fluid comprises submerging the MEMS package in fluid.

46. The method of Claim 38, wherein providing an amount of fluid comprises touching a fluid carrier with fluid to the fill port.

47. A method of filling a fluidic MEMS package comprising:
providing the MEMS package with an inner cavity defined by a cover plate, a substrate and a bond ring;
providing the MEMS package with a fill port and an evacuate port, each being defined by the cover plate, the substrate and a respective one of a plurality of breaches in the bond ring;
at an entrance to the fill port, providing an amount of fluid at least sufficient to fill the inner cavity; and

selecting the fluid, substrate, bond ring and cover plate such that capillary forces draw the fluid into the inner cavity causing air within the inner cavity to evacuate through the evacuate port.

48. A spatial light modulator, comprising:

a substrate with a MEMS mirror array fabricated on a surface of the substrate;

a cover plate bonded to the surface of the substrate by a bond ring;

an inner cavity defined by the substrate, the cover plate and the bond ring; and

a fill port defined by the substrate, the cover plate and a breach in the bond ring.

49. The spatial light modulator of Claim 48, further comprising:

fluid sealed within the inner cavity.

50. The spatial light modulator of Claim 49, further comprising:

a seal disposed in the fill port.

51. The spatial light modulator of Claim 48, wherein the bond ring comprises at least one of a glass frit, adhesive, eutectic solder, solder mask material, anodic bond, covalent bond, laser weld or Sol-gel material.

52. The spatial light modulator of Claim 50, wherein the seal comprises at least one of an adhesive, organic adhesive, epoxy, solder or glass-based sealant.

53. A method of assembling a spatial light modulator comprising:

providing the spatial light modulator with a MEMS mirror array fabricated on a substrate and in a package comprising an inner cavity and a fill port;

providing a vacuum in the inner cavity;

at an entrance to the fill port, providing an amount of fluid at least sufficient to fill the inner cavity; and

providing pressure on the fluid causing the fluid to fill the inner cavity.